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Research Article

ACCUMULATION OF ORGANIC CARBON AND AVAILABLE NUTRIENTS IN SOIL FERTILIZED WITH LIGNITE HUMIC ACID AND FERTILIZERS UNDER SUBSURFACE DRIP FERTIGATION OF SUGARCANE CV. COC (SC) 24 IN COASTAL SOIL OF TAMIL NADU (INDIA)

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ABSTRACT

Agricultural soils in the coastal region have meager soil fertility characteristics because of their sandy textures, salt content, kaolinitic clays, low cation exchange capacity, diminutive soil organic carbon and nutrient contents. The decreasing trend in the productivity of sugarcane was noticed during recent years. Recently however, drip irrigation combined with fertigation has been found to benefit the farmers because of the very high efficiency of fertilizer use for such irrigation schemes. It has long been recognized that humic substances have many beneficial effects on soil and plant growth. The objectives of this study were to determine the impact of lignite humic acid additions with and without fertilizers on soil fertility characteristics. The lignite humic acid had a pH of 6.8, contained total organic carbon content of 9.36 g/litre. The potassium, nitrate, phosphate, sulphate, calcium and magnesium were 20.1, 12.5,0.1,0.09, 0.01 and 0.001 g / lit respectively. The combination of 125 per cent NPK with 15 litres of humic acid /ha recorded higher cane yield of 141.12/ha. When compared to conventional method. Reducing the fertilizer levels by 25 % with 20 litres of humic acid /ha resulted in the cane yield of 136.94/ha. The organic carbon content accumulation was found to be increased with application of graded doses of humic acid.The available nitrogen content was accumulated at 20 cm depth and near the drip point. Available phosphorus distribution was higher at 40 cm than other depth of soil layers. Similarly, higher available potassium was observed at 20 and 60 cm depth of soil and at near the drip point. Based on this study, application of 125 kg recommended dose of fertilizers with 15 litres of humic acid ha^{-1} may be recommended to improve yield of sugarcane cv CoC (SC)24 and fertility of coastal soils of Tamil Nadu. Lignite humic acid additions to the coastal soil caused significant fertility improvements

***KEYWORDS:** Lignite Humic Acid, Rhizosphere, Soil Conditioner, Soil Nutrient Dynamics, Sub Surface Drip Fertigation*

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INTRODUCTION

India has the largest area under sugarcane cultivation in the world and is the world's second largest producer of sugarcane next only to Brazil. Though Tamil Nadu accounts only for about 11 per cent of the

production and nearly 6 per cent of the area under sugarcane of the country, this state has unique distinction of giving highest yield. Drip irrigation in sugarcane is a relatively new innovative technology that can conserve water, energy and increase profits. Thus, drip irrigation may help solve three of the most important problems of irrigated sugarcane - water scarcity, rising pumping (energy) costs and depressed farm profits. Application of water at the time of actual need through subsurface drip with right quantity of water to wet the effective root zone of soil to save the precious water. Farmers generally apply inorganic fertilizers due to their easy availability and scarcity of organic manures. The physical, chemical and biological properties of soil get adversely affected due to continuous use of chemical fertilizers resulting into low yield of sugarcane. Humic acid is not a fertilizer, but instead a compliment to fertilizer and essentially helps to move nutrients from soil to plant. 100% recommended dose of fertilizers through subsurface drip with humic acid showed favourable morphological growth characters and improved yield attributes of aerobic rice (Vanitha and Mohandass,2014). Use of humic acid as soil conditioner may be feasible in the case of increase in production combined with reduction of mineral fertilizer. The present study for that reason explored the full potential of humic acid through sub surface drip fertigation along with N P and K fertilizers on yield of sugarcane and fertility of soil.

Methods

Field experiments were conducted at Sugarcane Research Station, Cuddalore to study the effect of different dose of recommended fertilizer and humic acid on soil health and productivity of sugarcane CoC (SC) 24 through Sub Surface Drip Fertigation System. The sugarcane cv CoC (SC) 24 was grown during the crop season in the area spanning from 2012-2014 in Randomized Block Design with following treatment schedule.

Treatment Schedule

Table 1

T_{1-}	Conventional Method of Irrigation-	@ 100 % Recommended NPK / Ha
T_{2-}	Sub surface drip irrigation -	@ 100 % recommended NPK / ha
T_{3-}	Sub surface drip irrigation -	@ 125 % recommended NPK +15 lit. Lignite Humic acid (LHA) / ha
T_{4-}	Sub surface drip irrigation -	@100 % recommended NPK + 20 lit LHA / ha
T_{5-}	Sub surface drip irrigation -	@75 % recommended NPK + 25 Lit LHA / ha
	Recommended Fertilizer :	300:100:200 kg NPK/ha.
	Experimental Design :	Randomised Block Design
	Replication :	Four

In the case of surface/ conventional method, recommended practices were followed. In case of conventional irrigation treatment, irrigation was scheduled at 1.25 IW/CPE ratio throughout the crop growth. Sugarcane yield was recorded. Soil samples were collected at 150 Days After Planting at three different depths (viz., 20,40 &60 cm) and three different distance from drip point (0,45 &90 cm) horizontally and analysed for nutrient accumulation pattern. Organic carbon was determined by the Walkley–Black method (Nelson & Sommers, 1996). The available soil nitrogen (Subbiah and Asija, 1956), phosphorus (Olsen *et al*, 1954) and potassium (Standford and English, 1949) were analyzed.

RESULTS AND DISCUSSIONS

Properties of Humic Substances

The pH of lignite humic acid was 6.8 and total organic carbon content was 9.36 g/litre. The potassium, nitrate, phosphate, sulphate, calcium and magnesium were 20.1, 12.5,0.1,0.09, 0.01 and 0.001 g / lit respectively.

Effects of Humic Acid Fertigation on Cane Yield

The yield was recorded for plant crop and the results are furnished below. Subsurface drip fertigation positively influenced the yield of sugarcane. The cane yield (Figure 1.) was significantly improved by combined application of different dose fertilizers and humic acid through subsurface drip fertigation which could be due to boosted tiller production, grand growth and biological efficiency of the cane. The combination of 125 per cent recommended NPK with 15 litres of humic acid recorded higher cane yield of 141.12/ha. when compared to conventional method. Reducing the fertilizer levels by 25 % with 20 litres of humic acid /ha resulted in the cane yield of 136.94/ha. The yield was found to be progressively increased with increase in the level of NPK fertilizers with humic acid. These results are in agreement with the findings of Mahendran *et al*. (2005) who reported that fertigation up to 125 per cent of recommended dose of N and K in 14 equal splits up to 210 DAP to sugarcane crop resulted in higher cane yield of 173.5 t ha^{-1}. Regarding irrigation methods, subsurface drip is more favorable in increasing the cane yield than conventional irrigation method. The soil moisture kept above the field capacity with lignite humic acid by the frequent irrigation (once in 3 days) and nutrient supply match with the crop growth demand along with the soil good aeration throughout the crop growth period under SSDFS might have favoured the faster cell division and cell elongation which ultimately resulted in higher tiller production and yield. The increase in cane yield was mainly due to increased individual cane length, girth and number of internodes and this favourable influence was due to better and adequate supply of a required quantity of water and nutrients at the right time at right place due to sub surface drip fertigation.

Effects of Humic Acid Fertigation on Soil Nutrient Dynamics

Organic Carbon

The organic carbon content of the soil at different depths (Figures 2 &3) increased significantly to 0.592 per cent in 20 cm depth of soil due to the application of 75 % NPK with 25 litres of lignite humic acid/ha (T_5) as against the lower organic carbon content of 0.492 per cent in 100 % NPK without lignite humic acid under conventional method (T_1). When along with inorganic fertilizers + graded doses of lignite humic acid viz., 15, 20 and 25 litres/ha. Increased the organic carbon content to 0.512, 0.575, 0.587 and 0.592 per cent respectively. This could be due to the reason that the effect of lignite humic acid excelled along with inorganic fertilizers at later stage and also due to the release of organic acids and compounds into the soil. The organic carbon content availability was maximum at 20 cm depth than other depth of soil layers which can improve the soil properties such as aggregation, aeration, permeability, water holding capacity, hormonal activity, microbial growth, organic matter mineralization and solubilisation and availability of microelements (Venkatakrishnan and Ravichandran,2012). Organic carbon had limited mobility within the soil layers up to 60 cm, with which higher concentrations in the surface layer for all treatments.

The nutrient dynamics pattern showed that the application of lignite humic acid promoted significant accumulation of organic carbon from the drip point horizontally in the soil. The highest organic carbon content near the drip point (0 cm) was for in the 75 % NPK with 25 litres of lignite humic acid /ha. (T_5), followed by 100 % NPK with 20 litres of lignite humic acid/ha and 125 % NPK with 15 litres of lignite humic acid/ha.

Available Nitrogen

From the results (Figures 2 &3), it could be noticed that additional rates of fertigation had a significant effect on soil available N remained at three depths. Generally, addition of humic substances jointly with N, P and K improves the

soil fertility status at different layers. The highest available nitrogen levels for all the treatment in the 20 cm layers but lower in the 40 and 60 cm layer in all the treatments. The highest available nitrogen concentration in the surface layer was for in the 125 % NPK with 15 litres of lignite humic acid, followed by 100 % NPK with 20 litres of lignite humic acid/ha and 75 % NPK with 25 litres of lignite humic acid /ha. For all depths, the available nitrogen concentrations for the treatments with mineral fertilizer showed differences when compared to the control. The highest available nitrogen levels (292.79 kg/ha.) were observed for 125 % NPK with 15 litres of lignite humic acid treatments in the surface layer, decreasing with depth and is mainly due to the fact that fertilizer and humic acid applied through subsurface drip fertigation is retained in the organic fractions in an available form which may also be related with increasing solubility.

The application of lignite humic acid promoted significant accumulation of available nitrogen content from the drip point horizontally in the soil. This accumulation was maximum near the rhizosphere in all the treatment and maximum values were in the lignite humic acid @15 litres along with 125 % NPK fertilizers used followed by 100 % NPK with 20 litres of lignite humic acid/ha and 75 % NPK with 25 litres of lignite humic acid /ha.

Available Phosphorus

The highest available P content (Figures 2 &3) was observed in the 40 cm than other depths of soil layers. The highest available phosphorus content was observed for 100 % NPK with 20 litres of lignite humic acid/ha treatments in the sub surface layer. This subsurface accumulation was due to the higher translocation capacity of this ion. The nutrient dynamics pattern showed that the application of lignite humic acid promoted significant accumulation of available phosphorus from the drip point horizontally in the soil.Similarly the highest available P accumulation in 45 cm from the drip point was for in the 125 % NPK with 15 litres of lignite humic acid acid/ha followed by the 100 % NPK with 20 litres of lignite humic acid/ha.

Available Potassium

The accumulation of available K was observed at 20 and 60 cm depth of soil. (Figures 2 &3), the highest concentration were observed for 100 % NPK with 20 litres of lignite humic acid/ha treatments near the drip point of surface layer, decreasing with increasing width from the rhizosphere. Sustained level of crop nutrition requires optimum and conducive rhizosphere environment to achieve the potential yield and maximum nutrient use efficiency. Hence through integrated use of fertilisers and humic acid, the microbial population and soil enzymes in rhizosphere soil could be build up for the efficient utilisation of nutrients (Sellamuthu and Govindaswamy, 2003)**.** Moreover, addition of humic substances with mineral fertilizers maximized the available K content in soil. This may be due to improve the plant physiological processes by enhancing the availability of major and minor nutrients as well as enhancing the vitamins, amino acids, auxin, cytokinin and ABA contents of the plants, uptake and transport of humic substances into the plant tissues and improve soil health parameters.(Nardi *et al*., 2002).

CONCLUSIONS

Lignite humic acid increment increased yield of sugarcane. Based on the present study findings, 15 litres / ha lignite humic acid along with 125 % NPK application through sub surface drip fertigation systems to soil enhancing the yield of sugarcane cv CoC (SC) 24. The organic carbon and available nitrogen content was found to be increased with application of graded doses of humic acid and the accumulation was maximum at 20 cm depth and near the drip point. Available P distribution was higher at 40 cm than other depths of soil layers. Similarly, higher available K was observed at

20 and 60 cm depth of soil and at near the drip point. Moreover, addition of humic substances with mineral fertilizers maximized the available K content in soil. Further research is required in diverse plant environments to determine economically feasible application level of lignite humic acid while comparing it with other manures and organic fertilizer sources. This research was designed to provide information on soil fertility is an effort to help cane growers produce maximum economic yields and increase profitability in sugarcane production. These results have the potential to be applicable in sugarcane growing regions of coastal soils of Tamil Nadu.

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APPENDICES

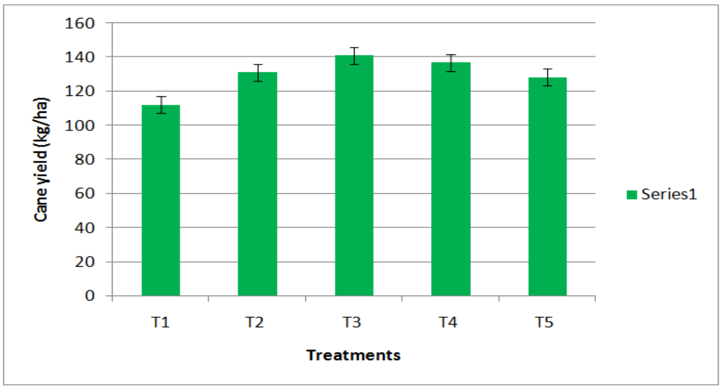

Figure 1: Effect of Fertilizers and Humic Acid on Sugarcane Yield (kg/ha)

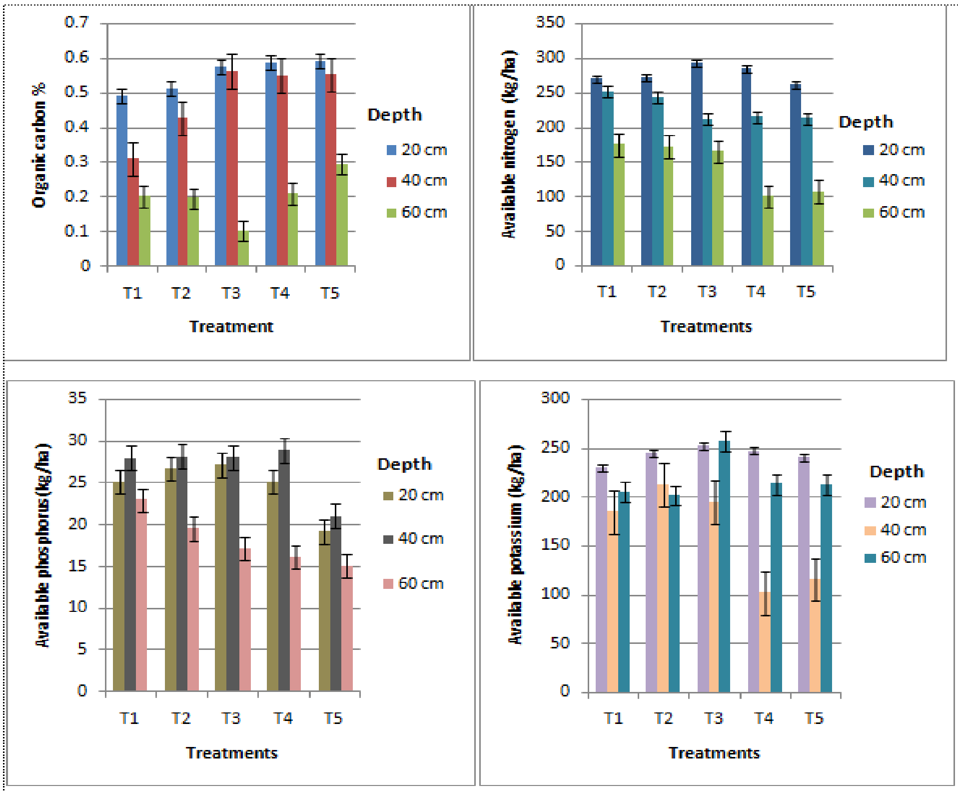

Figure 2: Effect of Fertilizer and Humic Acid on Nutrient Accumulation at Different Depth of Soil

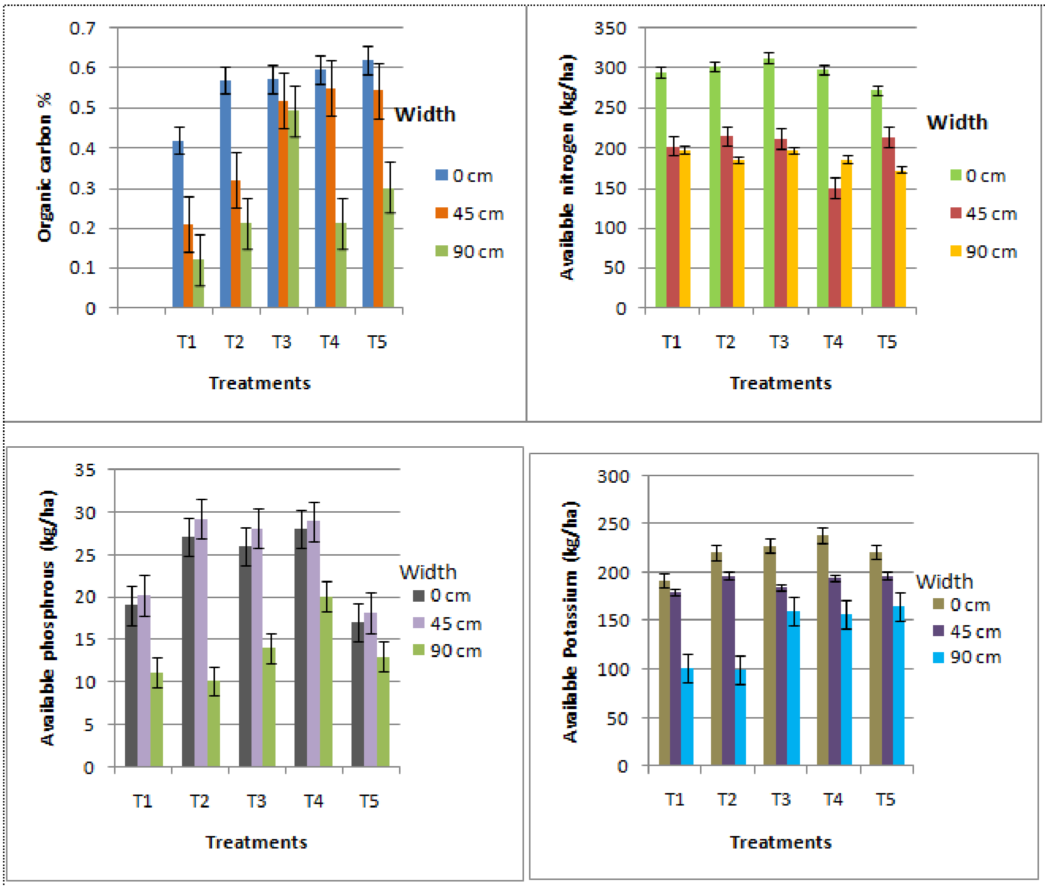

Figure 3: Effect of Fertilizer and Humic Acid on Nutrient Accumulation at Different Width of Soil